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RESEARCH AND APPLICATION OF ANTENNA TECHNOLOGY IN MOBILE 5G DEVICES

Abstract: This article describes the antenna technology and features of their upcoming use in 5G devices. Some methods for experimental testing of antennas and their parameters are briefly described. The basic properties of antennas of the considered types are studied as well as their approximate characteristics and basic parameters. The considered factors affecting the properties of antennas include the use of metal phone shells and anomalies created by the human body. Examples and illustrations showing the effect of anomalies in the radiation pattern are given. The main frequency ranges for using these antenna devices, their pros and cons are described. It was concluded that the 5G technology does not differ much from the antenna technology of mobile networks of the previous generation. The shape of the petals of the radiation pattern of the radiating antenna is influenced by many factors, including the human body which is capable of absorbing electromagnetic waves.

Keywords: radiation pattern and steering method, antenna, span, antenna array, the array.

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ИССЛЕДОВАНИЕ И ПРИМЕНЕНИЕ АНТЕННЫХ ТЕХНОЛОГИЙ В МОБИЛЬНЫХ 5G УСТРОЙСТВАХ

Аннотация: В этой статье описываются антенные технологии и особенности их предстоящего применения в устройствах 5G. Кратко описаны некоторые методы экспериментального тестирования антенн и их параметров. Изучены основные свойства антенн рассматриваемых типов, их приблизительные характеристики и основные параметры. В рассматриваемые факторы, влияющие на свойства сигнала, входят применение металлических корпусов телефонов и аномалии, создаваемые человеческим телом. Приведены примеры и иллюстрации, демонстрирующие влияние аномалий на диаграммы направленности. Описаны основные частотные диапазоны применения данных антенных устройств их плюсы и минусы. Сделан вывод о том, что технологии 5G мало отличаются от антенных технологий мобильных сетей предыдущего поколения. Форма лепестков диаграммы направленности излучающей антенны зависит от многих факторов, в том числе от человеческого тела, способного поглощать электромагнитные волны.

Ключевые слова: диаграмма направленности, метод рулевого управления, антенна, диапазон, антенная решетка, массив.

Currently, various mobile telecom operators in many parts of the world are testing individual network elements, as well as performing laboratory tests of 5G technology. Because of the approaching 5G technology, a paradigm shift in the way mobile device antenna frontends are designed is inevitable.

The fifth-generation wireless access is the next big step in the evolution of mobile communications, projected to be in place by 2020.

One of the major differences in 5G cellular systems if compared to 4G systems is the shift to millimeter-wave bands where it is easier to get more bandwidths.

In the past few years, interests in the centimeter-wave and millimeter-wave bands have grown. In order to achieve communication speeds in 35 Gb/s, the 28 GHz band has already been allocated for the future cellular communication systems. On July 14, 2016, the Federal Communications Commission approved a 5G frequency spectrum, including 28 GHz, 37 GHz and 39 GHz. In test networks, the data transfer rate reaches 25 Gbit/s, a record data transfer rate of 35 Gbit/s was achieved in Russia during the testing of 5G technologies.

Since not only the antennas for receiving and transmitting millimeter waves, but also the corresponding radio transceivers, beam steering topologies and other algorithms are built into the mobile device, it is now necessary to develop antenna systems suitable for mobile devices.

The standards for deploying 5G networks are not currently contaminated, therefore we need to search and study the main directions of development of portable antenna systems design technologies, which will be used in mobile communication devices based on the technology of the fifth-generation networks.

For that we distinguish the following research questions:

1. Determine which kinds of antennae will serve in 5G networks.
2. Learn the basic parameters of these antennas.
3. Identify problems encountered when using data antennas in mobile devices.

5G: Basic information

While the 4th generation of mobile communications is beginning to exhaust its capabilities, engineers around the world are developing standards for the fifth generation of mobile communications. In the future, 5G technology should have a higher bandwidth and latency compared to 4G networks, Internet speeds of up to 2 gigabits per second.

In connection with the trend of reducing the power consumption of mobile devices, it is assumed that the equipment for communication will have less power consumption of equipment than devices which use outdated mobile communications of the previous generation.

At present, taking into account the network requirements for 5G, several frequency bands have already been approved, including 28, 37 and 39 GHz. But despite this, at the present time there are no massively used,

stable fifth-generation networks. Only test and commercial networks are targeted for a small number of users.

Now, given the requirements put forward for the data exchange protocols being developed, many tasks need to be solved. One of them is the development of suitable antenna devices that will be able to ensure the stable operation of 5G networks in the future.

Antenna technology in 5G

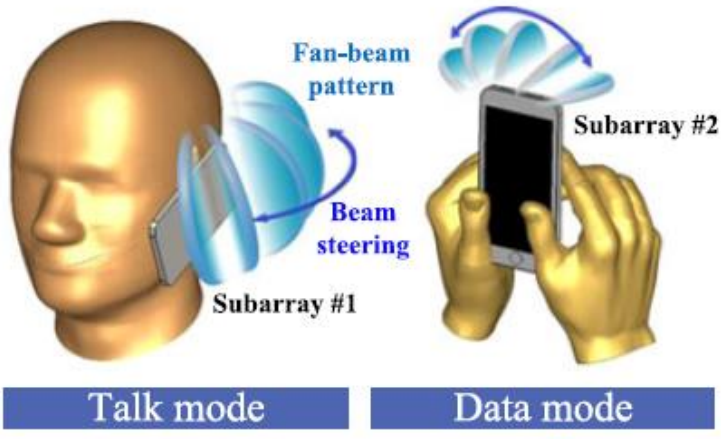
Currently, the most promising solution to the problem of developing antennas for networks of the fifth generation is the use of active phased patch antenna arrays, as for the 4G systems, and the use of the digital modulation method N-OFDM (Non-Orthogonal Frequency Division Multiplexing).

This type of antenna is a complex antenna system consisting of individual radiating elements with which, by changing the phases and amplitudes of the distribution of currents in individual elements, the radiation pattern generated by interference (superposition of coherent waves causing a change in their amplitudes) is changed. Changing the direction of the main lobe of the pattern is called beam steering.

The advantages of this system are increased in comparison with one element of the directivity factor (directional coefficient) and, as a consequence, antenna gain fast scanning of space due to the «sliding» the main lobe of the radiation pattern. In addition, due to the short wavelength in this frequency range, these antennas have small dimensions, which allow them to be embedded in mobile systems.

This technology is advantageous in that in the conditions of a moving transceiver and the appearance of interference in the form of a human body, it is necessary to take into account the orientation of the device in space and to control the beam, which is typical for phased antenna arrays (Figure 1).

Figure 1 – Concept of beam-steering characteristics of the designed 5G mobile handset antenna for a dual-mode scenario.



The influence of the human body on the antenna pattern

The shape of the petals of the radiation pattern of the radiating antenna is influenced by many factors, including the human body which is capable of absorbing electromagnetic waves.

In order to avoid this, beam control methods are used. For this, it is possible to use various methods, including switching between sub-arrays located in different parts of the apparatus.

Figure 1 shows two beam modes when using a mobile phone in various positions. In the case of conversational mode, the beam is directed from the back cover to avoid absorption and distortion of the radiation pattern by the human body. In the case when the phone is in the hands, the beam is directed from the top edge of the device by switching sub-arrays.

Thus, based on the foregoing, it can be concluded that the 5G antenna design technologies differ little from the antenna technologies of the previous generation of mobile networks. But despite this, there are still tasks that need to be solved to create an effective 5G antenna, including changing the frequency range (switching to millimeter waves), increasing transmission efficiency, reducing latency and increasing network capacity.

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